GUIDELINES FOR FLUORIDE IN WATER TREATMENT WORKS IN THE PROVINCE OF ONTARIO

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Jim Bradley
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FOR USE OF

FLUORIDE

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MINISTRY OF THE ENVIRONMENT

APPROVALS BRANCH

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1.0 PURPOSE OF THE GUIDELINES

The primary intention of these guidelines is to promote the safety of water plant operator personnel and assist persons designing and installing a fluoridation system.

These guidelines apply to MOE operated facilities only, and specify minimum requirements for all new construction, and are to be incorporated into all reconstruction of existing facilities. Design, engineering, construction, and the supply and installation of equipment for MOE operated facilities must comply with these guidelines.

2.0 DEFINITION

Fluoridation is the adjustment of the fluoride content of a public water supply to approximately 1.2 mg/L. The permissible operating range is 1.0 - 1.4 mg/L.

Most surface supplies have little or no natural fluoride content. Deep wells in Ontario range from

as little as 0.1 mg/L to higher than 2.4 mg/L, the maximum acceptable concentration as noted in the booklet "Ontario Drinking Water Objectives". Many well supplies, therefore, do not require fluoridation, whereas many need the addition of only a small amount of fluoride, or even defluoridation.

3.0 BASIC INFORMATION OF FLUORIDE CHEMICALS

The three most commonly used fluoride compounds are sodium fluoride, sodium silicofluoride, and hydrofluosilicic acid. Other compounds have been used in certain instances; however, these three compounds have the most widespread application. The chemical, physical, and other characteristics of sodium fluoride, sodium silicofluoride, and hydrofluosilicic acid are summarized in Table 1.

4.0 EQUIPMENT

4.1 Corrosion-Resistant Materials

The pH of the saturated solutions of sodium silicofluoride and hydrofluosilicic acid is 3.5 and 1.2 respectively. The pH of the saturated solution of sodium fluoride is 7.6. This means that it is essential to provide corrosion-resistant materials when handling both sodium silicofluoride and the hydrofluosilicic acid.

TABLE 1: CHARACTERISTICS OF FLUORIDE COMPOUNDS

ITEM	SODIUM FLUORIDE NaF	SODIUM SILICOFLUORIDE Na_2SiF_6	HYDROFLUOSILICIC ACID H_2SiF_6
Form	Powder or Crystal	Powder or Very Fine Crystal	Liquid
Molecular Weight	42.00	188.05	144.08
Available Fluoride Ion - Percent (100-Percent Pure Material)	45.25	60.7	79.2
Kilograms Required Per ML For 1.0 mg/L^- at Indicated Purity	2.25 (98 percent)	1.68 (98.5 percent)	5.51 (23 percent)
pH of Saturated Solution	7.6	3.5	1.2 (23 percent solution)
Sodium Ion Contributed at 1.0 mg/L F^-	1.17	0.40	0.00
F Ion Storage Space - m^3/45 kg.	0.62-0.96	0.65 - 0.85	1.53 - 2.1
Solubility - at 25°C g/100 g water	4.05	0.762	Infinite
Weight - kg/m^3	1041 - 1442	881 - 1153	1.26 kg/L (30 percent)
Typical Commercial Purity - Percent	97 - 99	98 - 99	20 - 30
Shipping Containers	23 kg bags 45 kg bags 57 to 182 kg fiber drums, bulk	23 kg bags 45 kg bags 57 to 182 kg fiber drums, bulk	50 L carboys 200 L drums tank cars, bulk

4.2 Feeders

Fluoride feeders should be designed for the maximum instantaneous flows at the source of supply. Extremely high flows experienced during fires, hydrant flushing, etc. generally should not be considered in sizing the feeders.

Dry feeders of the volumetric or gravimetric type may be used. Volumetric feeders have to be equipped with a weigh scale and preferably equipped with a weighing mechanism and a loss-in-weight recorder. Solution feeders should be positive displacement type metering pumps.

The solubility of sodium silicofluoride varies considerably with temperature. Since this chemical is more soluble at the higher temperatures, it would be reasonable to assume that increasing the temperature of the water, by heating, would be a distinct advantage. However, it has been found that the rising vapours from the dissolving chamber moisten the chemicals in the hopper and cause them to clump together and to adhere to the feeding mechanism. These problems affect the accuracy of the feeders. For this reason, this method of increasing the solubility of sodium silicofluoride is seldom used.

If the chemical is not being completely dissolved, check the following:

1. Dissolving chamber too small - minimum size - 23 L.

2. Detention time too short - minimum time - 5 minutes.

3. Too little water is being provided - check water supply by metering.

4. Insufficient mixing - provide water jets or electric mixers.

5. Short circuiting - provide baffling.

4.3 Saturators

The saturator is a special application of a solution feeder. It is based on the fact that, regardless of water temperature, sodium fluoride has a maximum solubility of approximately 4% (18,000 mg/L as F), which allows devices for automatically preparing saturated solutions to be used. These devices eliminate the need for weighing sodium fluoride, measuring solution-water volume, and stirring to ensure dissolution.

The principle behind a saturator is that a saturated solution will result if water is allowed to trickle through a bed containing excess sodium fluoride. There are two general types of saturators - upflow and downflow. The upflow saturator is the most common type and is preferred because it requires less maintenance than the downflow saturator.

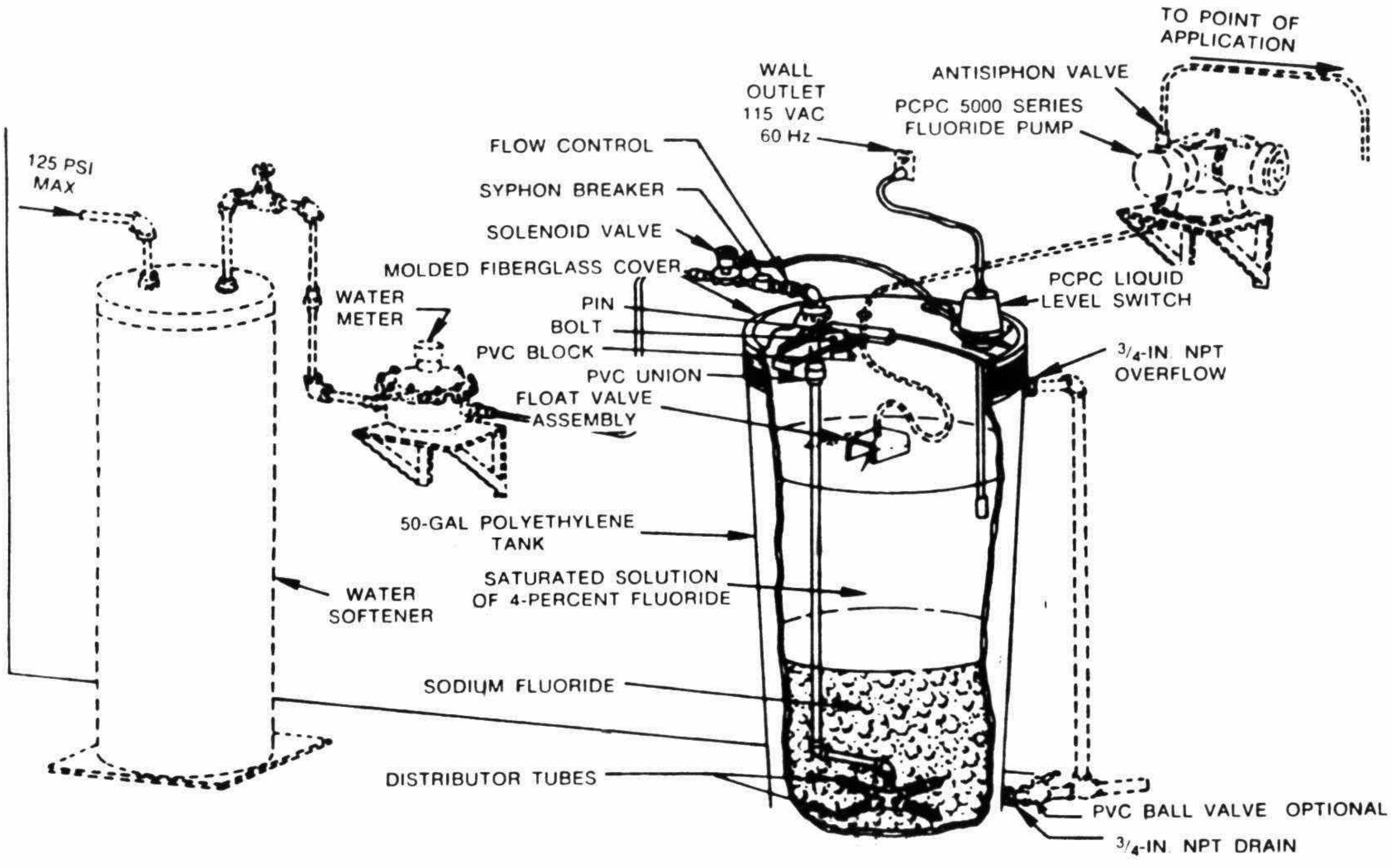


Figure 1 Precision Upflow Saturator

Upflow Saturator

In an upflow saturator, undissolved sodium fluoride forms a bed below which water is forced upward under pressure (Figure 1). As the water comes up through the bed of sodium fluoride, the specific gravity of the solid material keeps it from rising into the area of the clear solution above. A spider-type water distributor located at the bottom of the tank contains hundreds of very small slits. Water, forced under pressure through these slits, flows upward through the sodium fluoride bed at a controlled rate to ensure the optimum 4% solution. The feeder-pump intake line floats on top of the solution in order to avoid withdrawal of undissolved sodium fluoride. Since introduction of water to the bottom of the saturator constitutes a definite cross connection, a mechanical siphon-breaker or backflow preventer must be incorporated into the water line.

Because of the thick bed of sodium fluoride attainable in an upflow saturator, high withdrawal rates are possible. With 140 kg (300 lb) of sodium fluoride in the saturator tank, more than 57 L/h (12 gph) of saturated solution can be fed - a rate sufficient to treat about 27 ML/d (6 MIGD) of water to a fluoride level of 1.0 mg/L.

If the water supplied to the saturator is hard (more than 75 mg/L hardness), a household type water softener installed in the supply line will

minimize the amount of insoluble material accumulating in the saturator and increase the interval between clean-outs.

Downflow Saturators

In the downflow saturator, the solid sodium fluoride is held in a plastic drum or barrel and isolated from the prepared solution by a plastic cone or a pipe manifold. A filtration barrier is provided by layers of sand and gravel that prevent particles of undissolved sodium fluoride from infiltrating the solution area under the cone or within the pipe manifold. the feeder pump draws the solution from within the cone or manifold at the bottom of the plastic drum.

When a downflow saturator is in operation, water is admitted at the top of the saturator tank (where there is an air gap to avoid the possibility of a cross connection) and the level is regulated with a float-operated controller. The water then trickles down through the bed of sodium fluoride, the solution is clarified in the sand-and-gravel filter bed, and ends up as a clear, saturated solution at the bottom of the tank where it is withdrawn by the solution pump.

4.4 Hoppers or Day Tanks

Hoppers and day tanks should be designed to hold one day's requirements.

4.5 Dissolving Chambers (For Dry Feeders)

Dissolving chambers should be provided in all cases. In order to obtain continuously a solution of a dissolved fluoride compound from a dissolving chamber, it is advisable to limit the maximum solution strength to one-quarter of that of a saturated solution. This is based on a minimum detention time of 5 minutes in the dissolving chamber. In practice, dissolving chambers are seldom made with less than 23 L capacity. This size would be sufficient to dissolve sodium silicofluoride at the rate of 0.45 kg per hour or 11 kg per day. If sodium fluoride were used, five times as much chemical could be dissolved in the same size dissolving chamber.

The water supply to the dissolving chamber should be metered. Too much water reduces detention time and, therefore, reduces the opportunity for the chemical to dissolve. Too little water will increase solution strength and, therefore, reduce the speed at which the chemical dissolves.

4.6 Feeder Control

Feeder controls can be either manual or automatic. Manual control can be very accurate under ideal conditions, but requires constant

vigilance and a high order of skill. Automatic control, on the other hand, generally results in more accurate feeding.

Manual control is obtained by adjusting the feeder by hand, usually as the result in a change in the quantity of water to be treated. However, many other causes for a change in fluoride level may arise. These include changes in the purity of the fluoride compound, changes in the dissolving characteristics of the chemical and changes in the fluoride level in the raw water. This system is used frequently in the larger water plants where adequate analytical laboratory services are continuously available and where expert operators are constantly in attendance for adjusting feeders.

Two systems of automatic control are available. The pacing system is based on an adjustment of the feeder automatically, depending on the quantity of water to be treated. The other system of automatic control is based entirely on the fluoride level in the treated water. This, of course, requires the continuous automatic analysis of fluoride in the treated water and a means for adjusting the feeder to maintain a constant pre-set fluoride level. The latter method can be used to provide a continuous record and a graphic history of fluoride concentrations in the water.

5.0 CHECKING RATE OF FEED

A good installation requires that means be provided to check the feeder accurately for the amount of chemical being delivered.

Provisions for continuous testing are quite economical and simple to provide and should not be omitted. This operation provides a means of keeping necessary records and more closely controlling plant operations.

If hydrofluosilicic acid is pumped by a proportioning pump to the application point, the original acid container can be placed on a platform scale and loss in weight read at convenient intervals.

Loss-in-weight type gravimetric feeders have built-in scales that control the feed rate. Chart records can easily be attached to gravimetric feeders. Volumetric feeders can be provided with a loss-in-weight indicating and recording scale head.

If sodium fluoride solutions are to be pumped or measured by any other type feeder, several simple methods of continuous testing may be used. The simplest is a scale attached to the inside of the tank that can be easily read by the operator, although, for a deep tank, a float, cable, pulley and scale on the outside of the tank would be better. A sight glass will show the level in the tank at all times and, if connected to the tank and pump, will serve as a test gauge to show how much the pump is delivering with each stroke.

By providing an accurate water meter on the make-up water supply to a sodium fluoride saturator, a record of the sodium fluoride used may be kept.

Dry feeders for low rates of feed should be placed on a platform scale, as described above for acid tanks, and vernier indicators used to check the feed at low rates.

Dissolvers should not be on the scales of small feeders for two reasons:

1. When feeding a few grams per hour, the slightly fluctuating water level in the dissolver makes loss-in-weight tests unreliable, except for long runs.

2. Condensation on the dissolver increases in humid weather and runs down upon the scale, thus increasing the weight on it.

   Large dissolvers used for higher feed rates would also not be placed on scales because of their great weight.

6.0 POINT OF APPLICATION

The conventional application point for fluoride solutions is in filter effluent lines or in the clear well. At small plants using well supplies, and pumping stations, it is usually found advantageous to

inject the solution into the discharge side of the pump. It should be noted, however, that it is a definite advantage to be able to permit the liquid fluorides from the dissolving chamber of a dry chemical feeder to flow by gravity into the clear well or open channel. This generally requires that the feeder be located above and in close proximity to these structures.

Fluoride should not be added with or before coagulants or with softening chemicals. As much as one-third of the applied fluorides may be removed from the treated water when the alum dosage is 100 mg/L. In a few instances, it is economically justifiable to realize some loss of fluorides. Where transportation, storage, or handling costs of the fluoride compound can be substantially reduced by adding fluoride to the raw or partially-treated water, the loss of fluorides through the plant may not be a significant factor.

There are no known reactions between fluoride at 1.0 ppm in water and the compounds formed in water after chlorination. Thus, chlorine, chlorine dioxide, or chloramines can be added anywhere in the plant or distribution system.

Even though a well supply is not chlorinated, the addition of a normal fluoride solution would not provide a source of bacteriological contamination of the supply. Sodium fluoride solutions, for instance, are germicidal at only 5,000 mg/L (0.5% as sodium fluoride) and most such solutions are prepared considerably stronger.

The discharge line from the feeder should be as short and straight as possible, although circumstances sometimes require a long discharge line. When this is the case, sharp curves or loops in the line must be avoided, since they provide sites for precipitation build-up and subsequent blockage. If the solution is being injected into a pipeline, the injection fitting should preferably be installed near the bottom or underside of the pipe as shown in Figure 2. Injecting solution into the top of a pipe can cause air to collect and then work its way into the injection check valve or the discharge line and cause air-binding. Locating the injection fitting in the lower portion of the pipe also prevents the fluoride chemical (particularly hydrofluosilicic acid) from draining out of the injection tube, and possibly the discharge line, and settling to the bottom of the pipe causing corrosion.

The injection point should be at a higher elevation or a higher pressure than the elevation of the liquid level in the feed drum to reduce the possibility of siphonage and overfeeding. A check valve at the injection point and an antisiphon valve either at the feeder or at the injection point should be provided.

7.0 CHEMICAL STORAGE

The storage of chemicals should be in close proximity to the feeder. The chemical should be stored in a reasonably dry room, not directly on a concrete

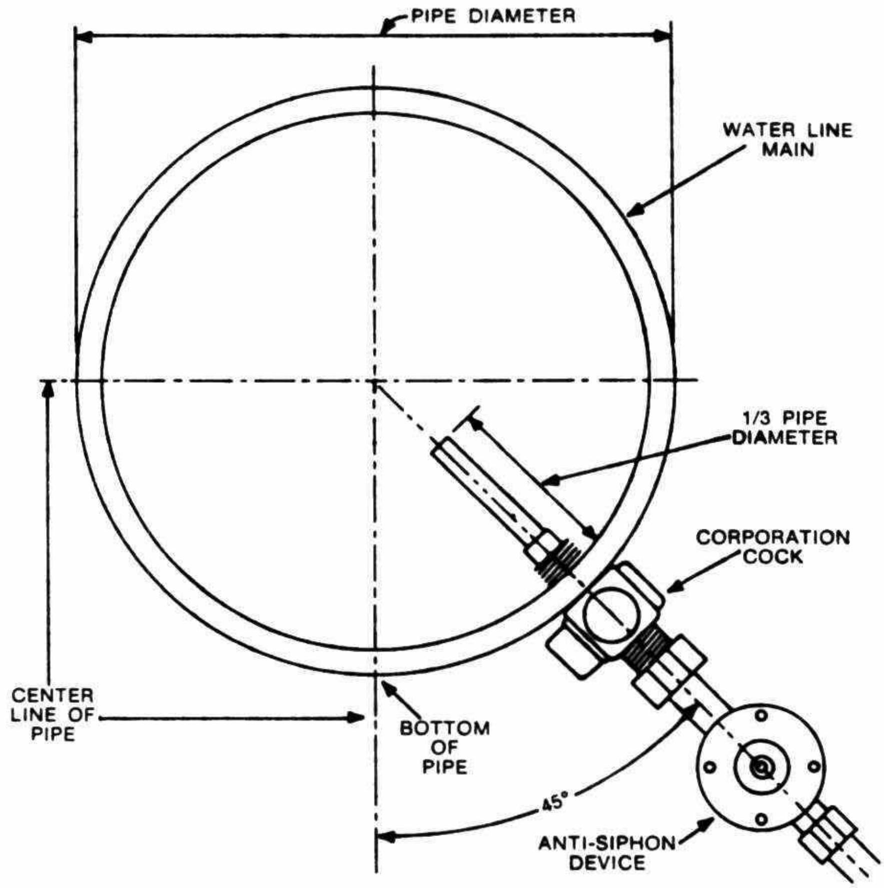


FIGURE 2: FLUORIDE INJECTION POINT

floor. Bags and even drums should be placed on boards or on grids to allow circulation of air to prevent sweating on the bottom.

Hydrofluosilicic acid must be stored either in unopened polyethylene carboys or in rubber-lined shipping containers to prevent the release of gases or vapours. Day tanks should be tightly covered and vented to outdoors.

8.0 COST CONSIDERATIONS

Based on fluoride content, sodium silicofluoride is the least expensive source. Sodium fluoride is about two and a half times as costly, while 30% hydrofluosilicic acid is about three times as expensive. These cost comparisons are based on the fluoride requirements for an average-sized plant.

For small water plants, the amount of chemical used is small enough that the cost per kilogram is not a major factor. Therefore, sodium fluoride or hydrofluosilicic acid, even though relatively expensive in small lots, can be used. The decision to use hydrofluosilicic acid, a manually prepared sodium-fluoride solution, or a saturator depends on the quantities to be fed, the skill of the operator, the availability and desirability of acid, and personal preference.

The simplest fluoridation installation is one based on the use of hydrofluosilicic acid. The acid is supplied in carboys or drums, mounted on a platform

scale. A solution feed pump, mounted on a shelf above the carboy, injects the acid into a main in proportion to the water flow. The feed pump should not be mounted more than 1.2 m (4 ft) above the top of the carboy. An antisiphon valve (Figure 3) is usually part of the feeder, and auxiliary equipment such as a loss-of-weight recorder can be added.

A sodium fluoride solution system is almost as simple. Essentially the same equipment is required as for the acid-feeding system plus that needed for make-up water. A sodium fluoride solution-feed installation may be arranged as shown in Figure 4 or the mixing tank and transfer pump may be eliminated by using the day tank for solution preparation.

The sodium fluoride saturator can be an extremely simple and virtually fool-proof solution-feed installation. Once the solution feeder has been adjusted, the only operator attention required is the occasional replenishing of chemical (without weighing) and the cleaning of the saturator.

Sodium silicofluoride and sodium fluoride dry feed are limited to water plants large enough to accommodate a volumetric or gravimetric feeder. Volumetric dry feeders are capable of feeding at very low rates, and some of the smallest disc types, such as those used for pilot plant installations, are able to handle water rates as low as 95 L/min (21 gpm). If an open channel for feeding by gravity from the dissolving tank is not available, an educator or centrifugal feed pump can be used for injecting fluoride solution into a main.

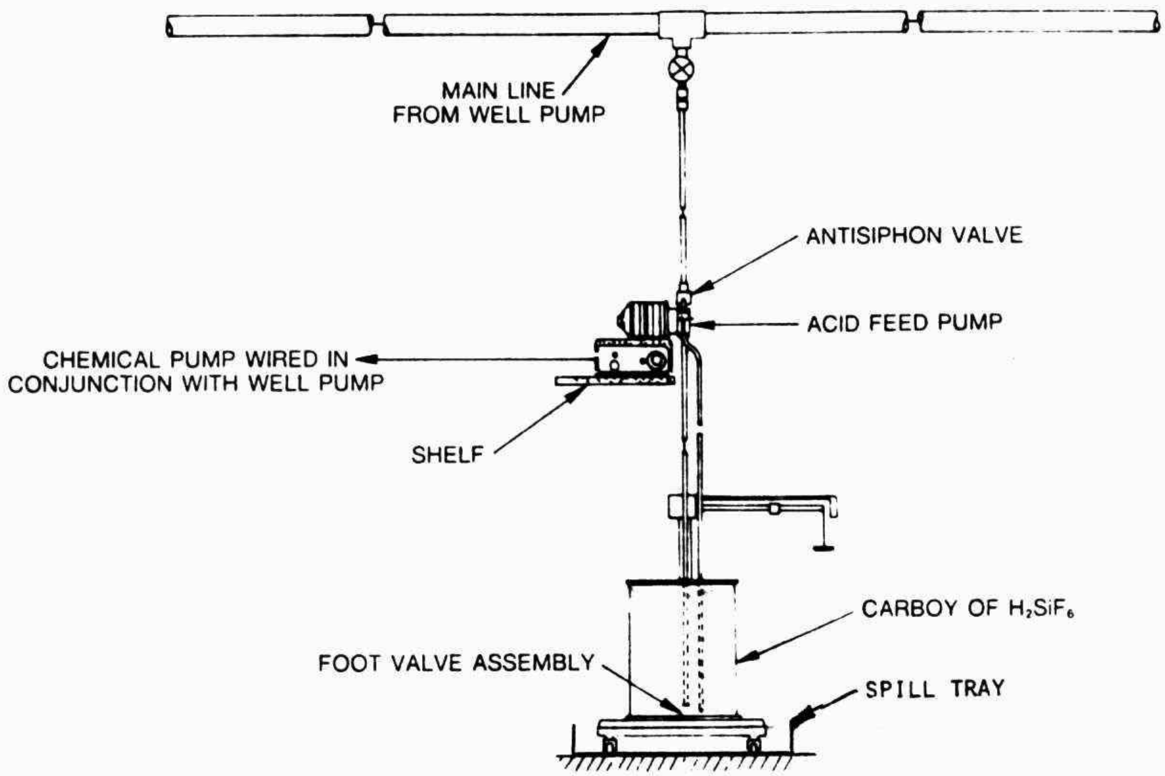


Figure 3 Acid Feed Installation

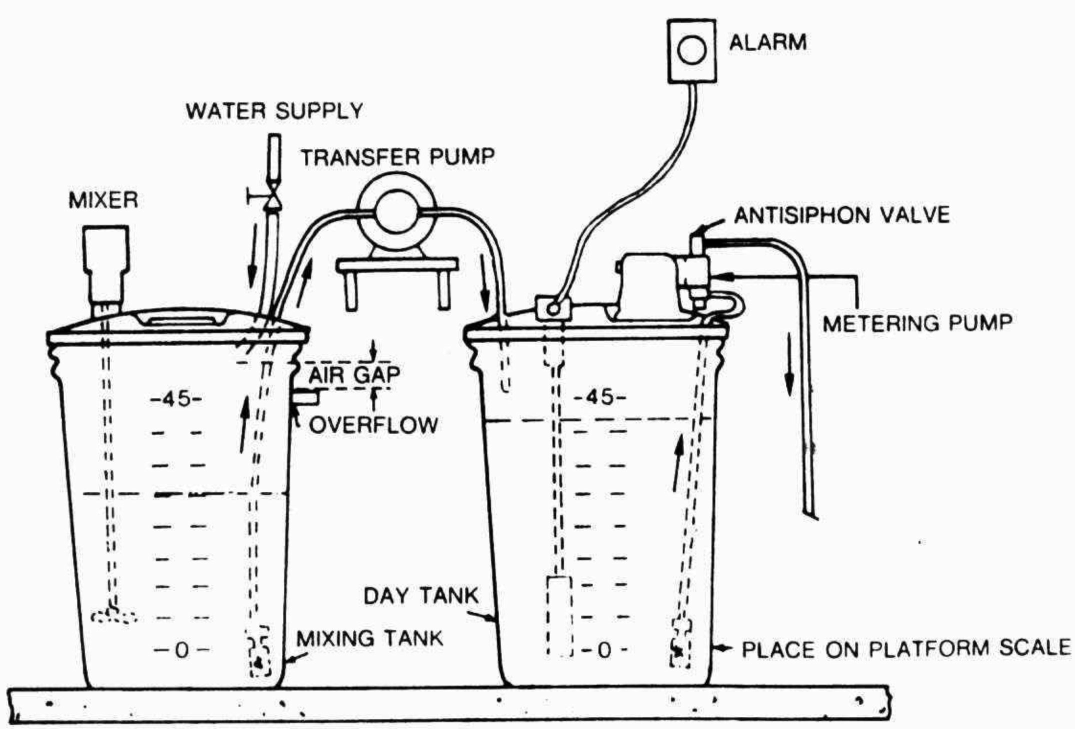


Figure 4 Solution Feed Installation

The roll-type and screw-type volumetric dry feeders are capable of handling flow rates from less than 6 L/s to several megalitres per day (100 gpm to several million gallons per day). Gravimetric dry feeders can treat flows from 6.8 ML/d (1.5 mgd) up to the greatest water usages encountered (Figure 5).

9.0 FEED RATE AND DOSAGE CALCULATIONS

Calculations can be simplified by using charts or tables, such as Table 2. The figures in the column at the extreme right of Table 2 can be use for calculating the amount of fluoride compound to add for quantities of water other than 1 ML (or mil gal). For example, the amount of 97% sodium fluoride needed for 10,000 L would be 10,000/1,000,000 or 0.01, the amount indicated. For 2 ML (or mil gal), the amount of fluoride compound needed would be twice as much and so forth.

Similarly, if other than 1.2 mg/L F is to be added, because of the presence of natural fluoride or because of an optimum concentration other than 1.2 mg/L, multiplying the figures in the right-hand column by the appropriate factor will give the number of kilograms to use. For example, if there is 0.7 mg/L F occurring naturally, and the optimum level is 1.2 mg/L, only 0.5 mg/L would have to be added, or 0.5 as much as indicated.

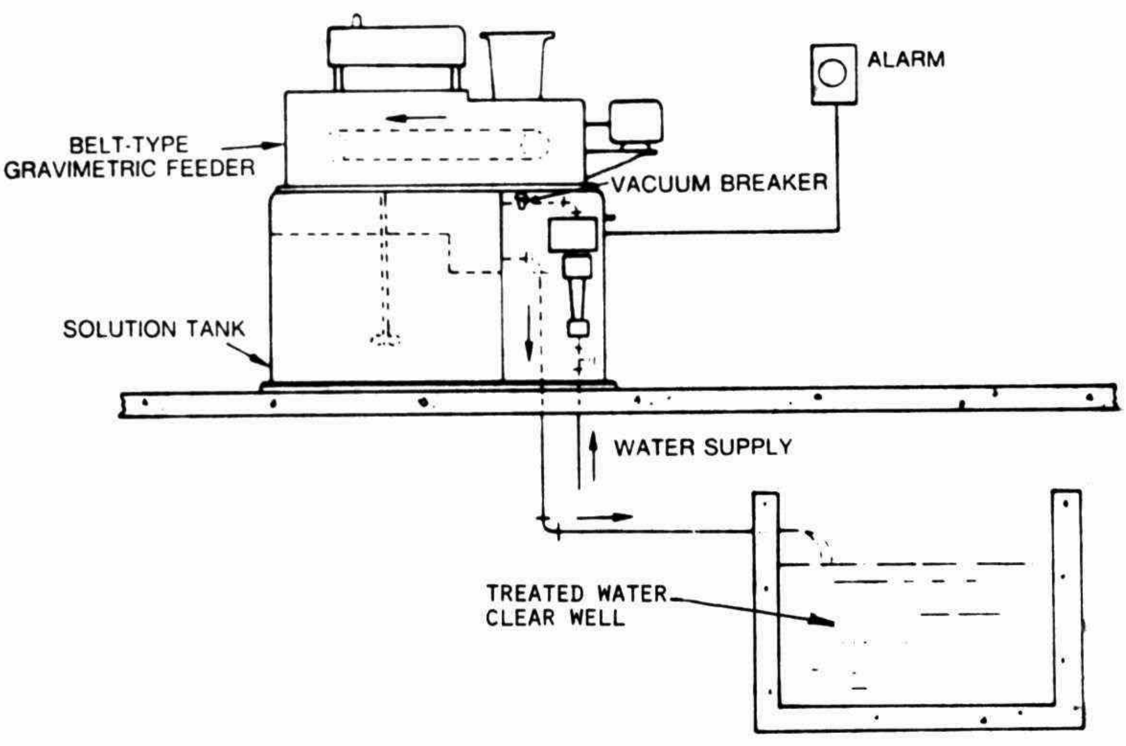


Figure 5. Dry Feed Installation With Gravimetric Feeder

TABLE 2: FLUORIDE CALCULATION FACTORS

COMPOUND	AVAILABLE F^- kg F/kg compound	COMMERCIAL PURITY %	COMPOUND REQUIRED for 1 mg/L kg per ML water	per mil gal water
Sodium Fluoride	0.4525	95	2.32	10.6
		96	2.30	10.4
		97	2.27	10.3
		98	2.25	10.2
		99	2.23	10.1
Sodium Silicofluoride	0.607	95	1.74	7.9
		96	1.74	7.9
		97	1.69	7.7
		98	1.68	7.6
		98.5	1.67	7.55
		99	1.65	7.5
Hydrofluosilicic Acid	0.792	20	6.29	28.6
		21	5.99	27.2
		22	5.73	26.0
		23	5.47	24.9
		24	5.25	23.8
		25	5.03	22.9
		26	4.85	22.0
		27	4.66	21.2
		28	4.48	20.4
		29	4.35	19.8
		30	4.22	19.2

Another device often used to simplify calculations is the nomograph, or alignment chart (Figure 6). Nomographs have been published both for specific compounds and for several different materials. They may or may not take into account the purity of the chemical.

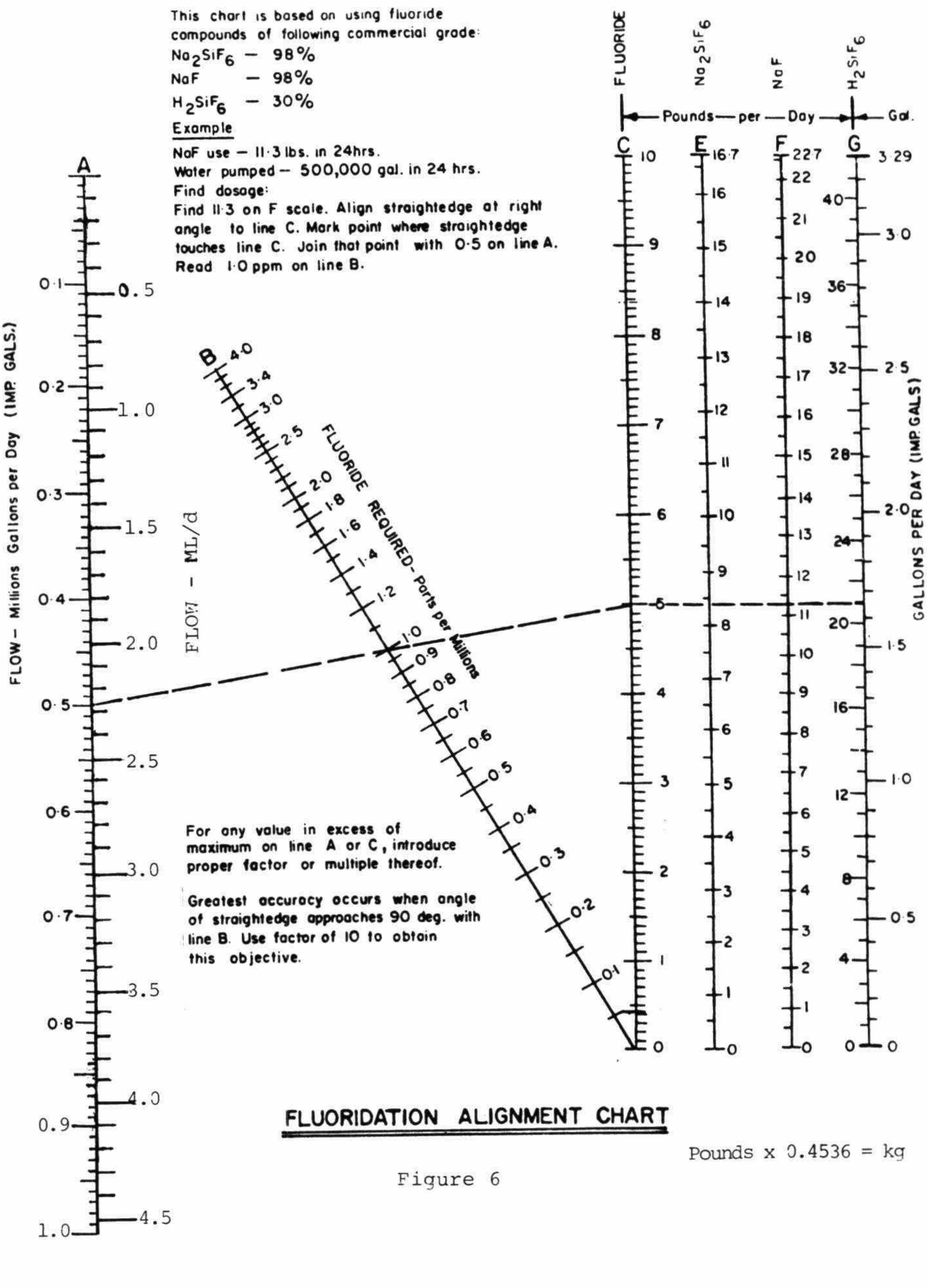
Tables and nomographs are generally not very accurate, but are useful for estimating chemical requirements or, by working backwards, for estimating the theoretical fluoride concentration achieved.

The ultimate check on concentrations should be the daily analyses of samples from the plant effluent and selected points in the distribution system. The amount of fluoride added each day and the amount of water to which it was added should be used to calculate the average dosage of fluoride as a check against the analyses results.

Table 3 is a checklist, based on water pumping rates, that can be used as a rough guide in selecting a fluoridation system. Other considerations, such as plant layout and personal preference, may influence a choice other than that indicated by the table.

10.0 SAFETY

The inhalation of fluoride dust is the principle hazard to operators. This can be minimized considerably by using crystalline sodium fluoride and other



FLUORIDATION ALIGNMENT CHART

Pounds x 0.4536 = kg

Figure 6

OPERATING PARAMETERS	SODIUM FLUORIDE MANUAL SOLUTION PREPARATION	SODIUM FLUORIDE AUTOMATIC SOLUTION PREPARATION	HYDROFLUOSILICIC ACID 23-30 percent	DRY FEED	
				SODIUM SILICOFLUORIDE	SODIUM FLUORIDE
Water flow rate	Less than 2.7 ML/d (0.6 MIGD)	Less than 11 ML/d (2.4 MIGD)	More than 2.7 ML/d (0.6 MIGD)	More than 0.55 ML/d (0.12 MIGD)	More than 7.67 ML/d (1.7 MIGD)
Population served by system or each well of multiple-well system	Less than 5000	Less than 10,000	More than 10,000	More than 10,000	More than 50,000
Equipment required	Solution feeder, mixing tank, scales, mixer	Solution feeder, saturator, water meter	Solution feeder, day tank, scales, transfer pump	Volumetric dry feeder, scales, hopper, dissolving chamber	Gravimetric dry feeder, hopper, dissolving chamber
Feed accuracy	Depends on solution preparation and feeder	Depends on feeder	Depends on feeder	Usually within 3 percent	Usually within 1 percent
Chemical specifications and availability	Crystalline NaF, dust-free, in bags or drums; generally available	Downflow - coarse crystalline NaF in bags or drums, may be scarce; Upflow - fine crystalline NaF	Bulk acid in tank cars or trucks; available on contract	Powder in bags, drums, or bulk; generally available	
Handling requirements	Weighing, mixing, measuring	Dumping whole bags only	All handling by pump	Bag loaders or bulk-handling equipment required	
Feeding point	Injection into filter effluent line or main	Injection into filter effluent line or main	Injection into filter effluent line or main	Gravity feed from dissolving chamber into open flume or clearwell, pressure feed into filter effluent line or main	
Other requirements	Solution water may require softening	Solution water may require softening	Acid-proof storage tank, piping, etc.	Dry storage area, dust collectors, dissolving chamber, mixers, hopper agitators, eductors, etc.	
Hazards	Dust, spillage, solution preparation error	Dust, spillage	Corrosion, fumes, leakage	Dust, spillage, arching, and flooding in feeder and hopper	

TABLE 3: FLUORIDATION CHECK LIST

granular forms which contain practically no particles small enough to form dust. Careful handling of the powdered compounds, either while emptying barrels or when transferring small quantities from the shipping containers to solution tanks, is most important.

The operator should follow all instructions as provided by the manufacturer. Spilt fluorides should be removed by wet mopping. Masks should be worn to protect operators in the event dust is accidentally generated. Rubber gloves should be worn because fluorides are a skin irritant. Body surfaces exposed to fluoride dust should be washed thoroughly with water. Where large quantities of fluorides are dumped into feeder hoppers from barrels or bags, blower operated dust collectors should be installed in the hoppers. Pneumatic conveyors should be vacuum operated.

Present practice in water treatment plants is to obtain equipment permitting the fluoride feeder hopper to be filled no more than once a day. If reasonable care is used in handling the fluorides so as to produce the least dust, little danger to the operators is involved.

For a small plant, the proper design of the hopper or loading door will permit placing the entire container within the hopper to allow the bag or drum to empty itself after the door is closed.

Actually, the greatest hazard occurs in the larger plants, where the fluorides are dumped from a barrel into a hopper opening which is at floor level. Occasionally, the fluoride arches in the barrel and then suddenly emptying, throws a cloud of dust into the air. In such installations, the dust exhaust system should be made part of the hopper equipment.

Of the available materials, hydrofluosilicic acid is by far the least hazardous. There is, of course, no dust for employees to breathe and there is no occasion, with a properly vented installation, for employees to breathe any fumes whatsoever. Rubber gloves, goggles, and rubber aprons should be used when handling drums.

For further safety precautions, handling of protective clothing after use, waste disposal and employee urine testing, refer to Section XVIII of the MOE Safety Manual.

11.0 BUILDING REQUIREMENTS

11.1 General

Provide a separate fluoride room for acid or dry chemical storage and feeding equipment. The main hazard, as noted under Safety, is the inhalation of acid fumes or fluoride dust, consequently, adequate room ventilation should

be provided. Eliminate sharp corners and ledges on walls, doors and windows where dust can accumulate and cleaning is difficult.

Dust hoods with exhaust fans must be provided over feeder hoppers.

Acid day tanks or large storage tanks must be tightly covered and vented to outdoors.

Provide a concrete containment curb around indoor hydrofluosilicic acid storage container.

11.2 Location and Size

a) Construct the fluoride room above grade at ground level, and locate as close as possible to the use point.

b) Arrange the room to have one external wall.

c) Locate floor mounted equipment with not less than 0.9 m (36 in) clearance on all sides.

d) Locate wall mounted equipment not less than 0.6 m (24 in) from a corner and not more than 1.8 m (6 ft) above floor level.

11.3 Floor, Wall, and Ceilings

a) Use only fire resistant material for construction.

b) Provide floor of concrete sloped toward door or drain at 1% grade.

c) provide impermeable ceilings, e.g., precast concrete. Do not use suspended ceilings.

d) Seal floor and ceiling joints air tight from the rest of the building.

e) Seal and paint all interior walls with corrosion or chemical resistant finish.

11.4 Windows

a) For natural light, locate sill 1.5 m (60 in) above floor.

11.5 Doors

a) Provide doors on <u>external walls only</u> - direct access to the rest of the building is not permitted.

b) Provide two or more doors if distance to be travelled to exit is over 4.5 m (15 ft). Do not exceed a distance of 7.6 m (25 ft) to an exit.

c) Hinge doors to swing outward and equip with bar type panic-hardware, and self closer. Locate the catch side toward the normal access route.

d) Provide all doors of hollow steel or kalamine construction with flush thresholds.

e) Post "Danger Fluoride Storage" signs on wall at latch side of door, directly over wall switches.

11.6 Floor Drains

a) Preferably, do not provide. Floor drains can be provided in large plants, discharge to a sewer, soak pit, or drainage system separate from that employed by the rest of the plant.

b) Construct of corrosion-resistant material.

c) Provide a dripping trap at each drain.

12.0 ELECTRICAL

12.1 General

a) Locate only the basic controls essential to operation, heating, lighting, and ventilation in the chemical rooms.

b) Use only motors of the totally enclosed type (TEFC or explosion proof).

c) Install conduit with the minimum restriction of access for servicing of equipment.

d) Connect all chemical room circuits to emergency power panel.

12.2 Lighting

a) Provide adequate lighting for safe working conditions at operation and service areas. Minimum light intensity 540 lux.

b) Provide 1.2 m fluorescent fixtures, surface or suspended type, industrial type, vapour proof.

c) Connect to the emergency generating set circuit OR provide an emergency lighting unit. Minimum two 25 W lamps and 30 AH battery.

d) Provide an outside light over the entrance/exit door(s).

12.3 Light and Fan Switches

a) Locate all switches outside the room.

b) For the ventilation fan, provide a switch at the exit door.

c) The switches on the outside of the wall by the exit door should be weatherproof and within 0.6 m of the latch side of the door.

d) Identify the switches clearly.

e) The outside light over the door(s) may be turned on with other outside lights.

12.4 Conduit and Fittings

a) Provide rigid PVC OR rigid steel, epoxy coated conduit. Equal to "Scepter" or "Conacote".

b) Surface mount the conduit clear of possible damage by chemical containers.

c) Arrange for direct connection to the equipment. Use flexible liquid tight conduit where necessary.

d) Seal all conduits passing to and from the room using "EYS" or "GUA" seal fittings filled with a sealing compound approved by Ontario Hydro.

13.0 HEATING

1. Provide electric unit heaters in the chemical and storage rooms OR hot water convectors. Do

NOT provide open flame heaters or hot air from a central system. Size the heater to maintain the room temperature at a minimum of 15°C.

2. The unit heaters are usually 575 V, 3 ph, with wall mounting bracket and built-in fan, magnetic contactor, control circuit transformer and thermostat. If one unit only is required, 5 KW is the recommended minimum rating (equal to "Chromalox" BUH).

3. Locate unit heater on the wall over 1.8 m above the floor and close to the outside corner if only one unit is required and a minimum distance of 3 m from stored chemicals.

4. Install heaters with the minimum restriction of access for servicing of equipment.

14.0 ROOM VENTILATION

1. Provide emergency and normal ventilation in the chemical and storage rooms as follows:

    a) Emergency exhaust fan to produce ten air changes per hour. Extend inlet to within 1 m (3 ft) of the floor.

    b) Normal exhaust fan to produce three air changes per hour OR natural ventilation.

c) Locate discharge of fans a minimum of 1.8 m (6 ft) from building openings, air intakes, walkways, etc., and a minimum of 5 m (16 ft) from dry wells, wet wells, manholes, etc.

d) If more than one fan is required, do not connect discharges into a common duct.

e) Locate inlet and exhaust openings on separate walls with a minimum of 2.5 m (8 ft) horizontal separation.

2. Inlet Openings

a) For emergency and normal ventilation, provide an opening in the roof or outside wall. Size the opening on the basis of 0.1 m^2 of free opening per each 50 m^2 of floor space. Assume 50% obstruction for screen and louvres. The frame opening to be not less than 0.1 m^2 and not to exceed 600 mm x 750 mm approximately. Provide rain cover or louvres and insect screen.

b) Locate the openings so that cold draughts will not strike the equipment or piping and arrange to give the maximum cross ventilation and prevent short circuiting.

3. Exhaust Opening for Emergency Ventilation

   a) Provide an opening for the emergency fan with an accessible gravity louvre on the inside wall.

   b) If the emergency fan is inside the room, provide a fixed weatherproof louvre at the outside of the opening.

   c) Locate the opening on the outside wall over 1.8 m above the floor at least 2.5 m above grade, away from air intakes and near the corner furthest from the single door.

   d) Arrange to give the maximum cross ventilation and prevent short circuiting.

   e) Size the opening to suit the capacity of the fan as per clause 14.1 (a) or larger.

4. Exhaust Opening for Normal Ventilation

   a) Provide an opening for the normal ventilating fan OR provide brick or block vents in the outside wall for natural ventilation. (Equal to "Construction Specialties".)

   b) Locate the exhaust opening(s) over 1.8 m above the floor, a minimum of 2.5 m above grade.

c) Provide an outside grille for the fan opening.

d) Size the natural exhaust ventilation opening the same size as for the inlet opening.

5. Emergency Exhaust Fan

a) Provide a centrifugal wall exhauster on the outside walls, preferably over 1.8 m above the floor, and at least 2.5 m above grade.

- If the fan is located outside, provide the unit in a weatherproof enclosure.

- If the fan is located inside, provide a single inlet self-contained assembly.

b) Provide the direct driven centrifugal fan with a totally enclosed motor. The fan should have a minimum static pressure of 13 mm water column at the required air flow. The motor should be rated 120 V, 1 phase, minimum capacity of 0.17 kW and a maximum speed of 1800 rpm. NOTE - Two-speed fans are not normally recommended because of the limited availability of a replacement motor.

c) Extend the suction air duct from the fan down to within 1 m (3 ft) of the floor.

d) Control the fan by two-way switches outside the fluoride room, one by the exit door and one by the observation window.

6. Normal Ventilation Fan

a) Provide a wall mounted propeller type fan over 1.8 m above the floor inside the room and at least 2.5 m above grade. NOTE - A centrifugal room exhauster of suitable capacity located outside the room may be used.

b) Direct drive the fan by a totally enclosed motor, rated 120 V, 1 phase, minimum of 0.06 KW.

c) Locate the fan control switch outside the room by the door. The fan is to run continuously.

15.0 EQUIPMENT VENTING

1. Vent the hydrofluosilicic acid storage and day tank to outdoors.

2. Provide vent lines of PVC pipe or plastic tubing - size and type as specified by the equipment supplier.

3. Slope continuously from a high point above equipment to point of atmospheric discharge to eliminate any moisture traps.

4. Construct discharges of vents as follows:

   - Terminate by a 90° elbow facing downward.

   - Covered by corrosion-resistant insect screen.

   - A minimum of 2.5 m (8 ft) above grade.

   - Located as per "room ventilation" [14.1 c)].

16.0 PIPING - CHEMICAL SOLUTION

1. Provide corrosion resistant material (e.g., rigid PVC pipe and inert plastic tubing).

2. Provide corrosion-resistant valving in solution lines, e.g.:

   a) Rubber lined diaphragm.

   b) Plastic ball type.

3. Locate metering pumps as close as possible to application point to minimize length of solutions lines.

17.0 EQUIPMENT REQUIREMENTS

1. Provide scales of the platform type recessed into floor to put platform at floor level. Scale may be of beam or dial type.

2. Provide an eye wash fountain immediately outside the fluoride room door within 4.5 m of the fluoride application area, preferably in a separate entrance vestibule.

3. Provide a self-contained breathing apparatus of at least 30-minute duration, pressure demand type, with spare cylinder(s), to be located in the same general area, outside of the fluoride room.

4. Provide protective goggles, aprons, rubber gloves, rubber slickers, and safety footwear for persons loading, storing, or handling chemicals. Do not store them in the fluoride room.

18.0 REFERENCES

1. For more detailed information, refer to:

"Water Fluoridation Principles and Practices", AWWA Manual M4.

Available from:

Ontario Section AWWA
45 - 23rd Street
Toronto, Ontario
M8V 3M6
Phone (416) 252-7060

2. MOE Safety Manual, Section XVIII.

3. MOE Ontario Drinking Water Objectives.